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STATISTICS OF THE FOOD SUPPLY IN GERMANY.*

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In the last fifty years Germany has changed from a food-exporting to a food-importing nation. Her agriculture, though protected in recent years by substantial tariff duties, has not been able to supply the growing demands for food-products arising from a largely increased population. Even before the war writers had pointed out the danger of a shortage of food in case of a European conflict. When the war came Germany found herself hemmed in on all sides by enemies, and cut off from her foreign sources of supply. Her foes have been unable as yet to make progress against the German armies; is it possible that they may achieve the same end, the defeat of Germany, by starving her out? Has Germany a sufficient home-production of food-stuffs to meet her most urgent needs?

The annual excess of imports over exports of food-products in normal times is considerable. In 1912 and 1913, years of exceptionally high home production, the excess of imports of grains and potatoes alone averaged 6,250,000 tons—2,000,000 tons of wheat, 3,000,000 tons of barley and 1,000,000 tons of corn, with smaller quantities of potatoes and rice. Meat and animal products, oil-cake and agricultural products used for fodder, were also imported in large quantities.†

Various estimates and guesses of the proportion of total consumption that is imported have been made. Low estimates of the dependence of Germany upon foreign supplies of food are based on the proportion, 10 per cent., of the bread-grains and 3–5 per cent. of the meat products, that is directly imported,‡ ignoring the fact that large amounts of meat and animal and vegetable products may be derived indirectly

* Paper read at the annual meeting of the American Statistical Association, Washington, D. C., December 29, 1915.

† Kuczynski and Zuntz, Deutschlands Nahrungs- und Futtermittel, Allgemeines Statistisches Archiv., Vol. IX, 1915, pp. 114, 137, 169, 173, 185–187.

‡ Ballod, Die Volksernaehrung in Krieg und Frieden, Schmollers Jahrbuch fuer Gesetzgebung, Verwaltung und Volkswirtschaft im Deutschen Reiche, Vol. 39, p. 77.

from abroad by import of fodder and fertilizers. Ballod, a German statistician who has written on the problem of the food supply, thinks that, including all kinds of vegetable food-stuffs imported, one third of all grains and vegetable food-products is imported; of meat products, one half comes directly or indirectly from abroad.* A careful and complete estimate has been made by Kuczynski and Zuntz, the former director of the Municipal Statistical Bureau of Berlin-Schöneberg, the latter director of the Institute of Animal Physiology of the Royal Agricultural High School in Berlin. In determining the proportion of food imported to the total consumed, the different kinds of food-stuffs are compared in terms of calories, or units of heat energy, contained in the respective foods; and also in terms of the amounts of protein, or nitrogenous compounds, a certain quantity of which is an indispensable part of the daily ration. Of the total consumption of food in the years 1912-1913, these two authors estimate that 29 per cent. of the protein and 20 per cent. of the calories were imported. Of the total grains and plant foods used for human consumption, there was imported 9 per cent. of the heat energy and 15 per cent. of the protein content. Of the total meat supply 44 per cent. of the protein and 43 per cent. of the calories were imported either directly in the form of live cattle and dressed meats, or indirectly in the form of fodder for cattle and hogs.†

These figures, relating to food-stuffs used for human consumption, give some idea of Germany's present problem. Since the war, imports have been almost wholly cut off. Imports of wheat and barley from Russia and America have been stopped. Holland, Denmark, Switzerland, and Sweden have little to spare and Rumania has been unwilling to permit free export.‡ Austria-Hungary is in no position to help Germany out.§ In addition to the loss of foreign supplies, home production has been seriously affected by the war. Five hundred thousand horses have been taken from the farms for

* Ballod, Deutsche Volksnaehrung im Kriege, Preussische Jahrbuecher, Vol. 157, 1914, p. 102.

† Kuczynski and Zuntz, *op. cit.*, pp. 153, 131.

‡ Rumania forbade the export of rye, barley, and peas and levied a heavy export tax on the export of corn. Jahrbuecher fuer National-Oekonomie und Statistik, Vol. 105, July, 1915; Volkswirtschaftliche Kronik, pp. 293-4. See below, p. 29.

§ Kuczynski and Zuntz, *op. cit.*, p. 107.

the use of the army; and the supply can not be replenished from Russia, from which the greater part of the normal import, 114,000 horses, came.* Crops in small portions of Alsace and East Prussia were damaged by movements of hostile armies.† Farm labor has been called to the front.‡ About 18 per cent. of the total males and females engaged in agriculture are males between the ages 18 and 49 and therefore subject to military duty. The fisheries on the North Sea are practically closed down.§ The import of Chili salt-peter, representing one half of the total supply of nitrogenous artificial fertilizer, has been cut off.|| The substitutes, a nitrogenous compound manufactured as a by-product from coke, and nitrolin, made by electrical process from the atmosphere, are either insufficient in quantity or can be produced only at high expense.

Writers on the question of the food supply of Germany before the war were apt to be pessimistic. Since the war, in the many discussions of the food problem that have been published, the prevailing tone has been optimistic.¶ Though a large proportion of the food-stuffs consumed by the population are imported, yet in case of need there are substantial reserves to which the optimists point. Part of the abundant potato crop is now used for industrial purposes. There is annually a large surplus of sugar for export, and the sugar may be used to take the place of the missing imports, or the sugar lands may be used for other crops.** Finally, the grain used in the production of beer and starch can be used for food. In reply to these arguments it has been pointed out by Professor W. J. Ashley that the relative food values of these reserve

* Eltzbacher (ed.), *Die deutsche Volksernährung und der englische Aushungerungsplan*, 1914, p. 15.

† Gumbinnen and Allenstein in East Prussia were overrun by the Russians, and about 5-6 per cent. of the crop of Prussia was destroyed. Ballod, *Die Volksernährung*, Schmollers Jahrbuch, Vol. 39, p. 88. A small portion of Alsace-Lorraine was invaded by the French. Eltzbacher, *op. cit.*, p. 16.

‡ Eltzbacher suggests that "the greater part" of the farmers and farm laborers are in the "field." *Id.*, p. 14. In 1907, 3,146,592 males between the ages of 18 and 49 were engaged in agriculture, or 18 per cent. of the total males and females engaged in agriculture. Statistik des Deutschen Reiches, Vol. CCIII, pp. 2-3.

§ Eltzbacher, *op. cit.*, p. 14.

|| W. J. Ashley, *Germany's Food Supply*, The Quarterly Review, Oct., 1915, p. 446.

¶ See K. Borman, *Die Lebensmittelversorgung des deutschen Volkes während des Krieges*, Deutsches Statistisches Zentralblatt, 1914, Vol. VI, column 286.

** Figures for sugar beet acreage for 1915 show a marked decrease, 31.9 per cent. over the acreage of 1914. Jahrbücher f. Nat.-Oek. u. Stat., Vol. 105, Volkswirt. Kronik, p. 290.

crops must be taken into consideration.* Foods contain protein, carbohydrates, and fats in varying proportions. Protein includes the nitrogenous compounds which are indispensable in rebuilding nervous tissue; neither of the other two constituents can take its place. There is a large proportion of protein in meats and the leguminous plants, and a fair proportion in wheat and other grains. Carbohydrates and fats are heat-producing. Potatoes are largely and sugar is almost exclusively composed of carbohydrates. The residues from the breweries, which contain a large proportion of the protein element of the grain used for the manufacture of beer, etc., have always been used as fodder for cattle, and thus indirectly have been utilized in the production of meat. It is therefore inadmissible to consider the total amount of grain used in the production of beer as a reserve.

An answer to the question, "Can Germany hold out?" has been attempted by a group of sixteen German statisticians, agriculturists, and physiologists and their conclusions have been published in a little volume edited by Eltzbacher,† the director of the School of Commerce of Berlin. Four main problems are investigated: (1) What was the total consumption of the population in 1912-13? (2) What is the total requirement of food of the German population? (3) What is the probable home-production of food-stuffs without considering any special emergency measures? (4) How much can the supply of food available be increased by special measures to be taken? The questions in which we are most especially interested are those relating to the statistical estimates of the food-supply. The statistical work seems to have been done largely if not entirely by Kuczynski and Zuntz.‡

The consumption for the total population of 1914 on the basis of the consumption, including normal imports, corresponding to the average of the years 1912 and 1913, would be 90,420,000,000,000 calories and 2,307,000 tons of protein. It is estimated that an adult man with moderate work daily re-

* W. J. Ashley, Germany's Food Supply, *The Quarterly Review*, Oct., 1915, pp. 444-462, esp. p. 447.

† Die deutsche Volksernährung und der englische Aushungerungsplan. Eine Denkschrift von Friedrich Aereboe, Karl Ballod, Franz Beyschlag, Wilhelm Caspari, Paul Eltzbacher, Hedwig Heyl, Paul Krusch, Robert Kuczynski, Kurt Lehmann, Otto Lemmermann, Karl Oppenheimer, Max Rubner, Kurt von Rumker, Bruno Tacke, Hermann Warmbold, und Nathan Zuntz. Edited by Paul Eltzbacher, 1914.

‡ See Kuczynski and Zuntz, *op. cit.*, note 2, p. 107.

quires food with heat energy of 3,000 calories, 11 per cent. of which, or 330 calories, is furnished by 80 grams of protein. Women and children require a somewhat less amount. Calculating the number of calories and the amount of protein required for the total population of 1914, the yearly physiological requirement for efficiency is estimated as 56,750,000,000,-000 calories and 1,605,000 tons of protein. The consumption for the two years preceding the war exceeded the physiological requirement, calculated on this basis, by 59 per cent. for heat energy and 44 per cent. for protein.*

The probable home-production of food-stuffs is calculated from the figures of the production of 1912-13 by deducting 5 per cent. to allow for a decrease due to lack of labor, horses, fertilizer, to the cutting off of the fisheries, and to the damage to crops in East Prussia and Alsace. The total production is estimated at 1,554,000 tons of protein and 67,680,000,000,-000 calories, a slight surplus of calories over the requirement but a deficit of 3 per cent. in protein.† The Eltzbacher report suggests a number of possible methods of making up this slight deficiency: lessening of household waste, slaughter of pigs and cattle to lessen the animal consumption of grains which might serve directly for human consumption, lessening of the use of grain in industry, development of the electric process for manufacturing nitrogen, culture of moorland, etc. By these measures it is calculated that 480,000 tons of protein can be added, transforming the deficit into a substantial surplus.‡

Professor W. J. Ashley, in a review of the Eltzbacher publication, criticizes these estimates on the ground that they are too optimistic. Wherever there is room for a difference of opinion as to the home-production or as to the requirement, he thinks that the authors have chosen the more favorable basis for estimate. His criticisms of the estimates are restricted mainly to the estimates of protein.

The figures for the supply of protein available from grains and potatoes are based on the assumption that the 1914 crop would be as good as the average of 1912 and 1913, with

* Eltzbacher, pp. 20-32, 64-66.

† Eltzbacher, *op. cit.*, p. 66-67.

‡ Id., p. 194.

an allowance of 5 per cent. for war conditions. Both of these crops, especially the 1913 harvest, were unusually good. The latest revision of the official estimates indicates, according to Ashley, that the 1914 crops fell about 13 per cent. short of the average of the two years preceding.* Furthermore, the official figures overestimate the crops. Ballod, a German statistician, thinks that the official figures are 10-15 per cent. in excess of the reality. Ashley reduces the figures for the protein content of grains and plant foods on the basis of a 15 per cent. reduction of the official figures for the 1914 crop from 963,000 to 753,000 tons. Estimates for the food value of cattle and hogs slaughtered are calculated by applying to the number of animals slaughtered the figures of the Health Department for the average "dead weight" per animal. But these averages, according to Ashley, are 10 per cent. too high. That they are too high is admitted in the Eltzbacher publication, but the averages are kept, "to include certain parts of the animal fats not fully included in the 'dead weights' though they are used for human consumption."† These animal fats are perhaps 5 per cent. of the total weight. Ashley reduces the estimate for protein 2 per cent. from 346,900 tons to 340,000 tons. He further criticizes the estimate for the annual average production of 2,200 liters (about 5,000 lbs.) of milk per cow and thinks that 2,000 or 1,800 liters is nearer the truth. He compromises, however, on 2,100 and reduces the estimate for protein in the milk supply by 5 per cent., or 8,300 tons. Accepting all the rest of the figures, these reductions would bring the estimate for the total available protein down from 1,554,000 tons to 1,411,000 tons.‡

Not satisfied with reducing the estimate of the supply available, Ashley revises the estimate for the physiological minimum necessary for the total population. The minimum requirement of protein necessary for efficiency as given by the "standard German author, Voit," is 118 grams of crude or 105 grams of digestible protein. Calculated on this basis the requirement would be not 1,605,000 but 2,001,000 tons of protein. Calculated on a basis of 92 grams of digestible

* Ashley, *op. cit.*, p. 449.

† Eltzbacher, p. 49.

‡ The deduction of 225,200 tons is made from 1,636,000 tons, the supply home-produced 1912-13.

protein, as suggested by Bauer* as the lowest figure consonant with efficiency, the requirement still would be 1,853,000 tons. To meet this requirement there would be available under normal conditions only 1,411,000 tons, a shortage of 24 per cent.

Finally Ashley believes that the estimate of 480,000 tons of protein added to the supply available by the measures of the government—the prohibition of the use of grain as fodder, reduction of the stock of pigs and cattle, agitation to decrease waste by housekeepers, etc.—is too high. He thinks the prohibition of the feeding of grain to stock was largely evaded at first on account of the large profits in meat production. There was a large percentage of waste incident to the storage of food by the government. A realization of one half of the saving hoped for would be, according to Professor Ashley, an outside estimate of the results achieved. On the other hand, Germany has been able to import or smuggle in food-stuffs by way of Holland and Denmark, the imports showing a very considerable increase over normal trade.

In conclusion Ashley calculates that there is a deficit of 12–13 per cent. of the food supply required—a deficit which is indicated by the great increase in the prices of food.† The abnormally high prices bring great suffering to the working classes in industrial districts. Meetings to discuss the prices of food-stuffs have been prohibited in Saxony. The agricultural population, on the other hand, has received some benefit from the high prices. Ashley thinks it was a mistake for the government to announce in an authoritative manner that there was food enough for all. If there is food enough, the question “Why should the prices of food-stuffs rise?” will naturally be asked among the working classes, with resentment against the inefficiency of the government in failing to stop speculation.

Are these criticisms of the German estimates well taken? If the German economists might tend to err on the side of overestimate, perhaps the Englishman might be inclined to be pessimistic about the food supply of the German people! No reference is made by Professor Ashley to an article which

* Handwörterbuch der Staatswissenschaften, Vol. VI, p. 135.

† Seventy per cent. in Berlin in one year. Ashley, *op. cit.*, p. 455.

appeared in the *Allgemeines Statistisches Archiv* in the spring of the present year, written by Kuczynski and Zuntz, who were responsible for the statistical estimates of the Eltzbacher publication.* In the later article the estimates are much more detailed, critical comments, notes, and references to sources, which are omitted in the popular edition, are given, and in some cases, data which were not before available are used to revise the earlier figures.

The first question to be taken up in examining Ashley's criticisms in the light of the sources used by the German statisticians is the revision of the estimate of protein available from grains and plant-foods. Ashley reduced it from 963,000 to 753,000 tons, or 210,000 tons. Eltzbacher allowed for a 5 per cent. reduction from the production before the war to allow for poor crops—a deduction of 48,150,† so that the discrepancy between the two is some 161,800 tons. Kuczynski and Zuntz in their revised estimates increase the allowance for poor crops, lack of labor, horses and fertilizers, losses due to the movements of hostile armies, etc., to 8 per cent. This reduces their earlier figures by 28,900 tons. The actual returns of the 1914 crop show that even this increased allowance was too low; actually the 1914 crop fell some 12 per cent. below the figures for the average of 1912 and 1913.‡ A further reduction should be made, therefore, in Kuczynski and Zuntz's figures of 30,000 tons of protein.

The remaining difference of approximately 100,000 tons is due to Ashley's reduction of the crop estimate for 1914 by 15 per cent. to allow for error in reporting the yield. In support of this procedure he appeals to the criticism of crop reports by Ballod.§ Estimates of crops in Germany, in normal times, are returned in November by a large number of agricultural experts, each of whom estimates or guesses at the average yield per acre of the principal crops in his district. The districts now average nearly 16 square miles. The figures of average yield are multiplied by the area under cultivation in each crop as reported by the communal authorities.

* See above, p. 96, note 3.

† The deduction of 5 per cent. was not restricted solely to grains, etc., used for human consumption, but included also 33,850 tons for indirect use of grains and fodder.

‡ A reduction of 12 for wheat; 12.5 for rye; 12.3 for barley, 0.8 for oats, and 14 per cent. for potatoes. Ashley's 13 per cent. reduction is therefore only slightly overstated.

§ Ashley, *op. cit.*, p. 449, note. See also the two articles by Ballod already cited.

Estimates of acreage can be compared with the results of agricultural censuses—in 1907 in Bavaria the estimates were slightly higher than the census figures.* The estimates of the communal authorities for the acreage in 1913, on the other hand, were almost uniformly lower than the results of the agricultural census of 1913.†

With reference to the estimates of average yield per acre, there is no direct way to test the figures. No agricultural census of crop production has ever been taken in Germany. In the United States estimates of crops are compared with census returns every 10 years and usually the census figures are taken as a new base for future estimates; each year the crop reporters report not an average yield for the district but the percentage yield of the present in terms of last year's crop. In Germany, there was no base to start from, the estimates have never been compared with census figures, and no one knows how far the estimated yields per hectare depart from the truth.

From 1893 to 1898 there were two different sets of crop estimates, one made by the agricultural experts (*landwirtschaftliche Sachverständige*), as at present, and the other by communal authorities, in most states usually in February after the harvest. In 1899 the second method was dropped, because the figures so obtained were almost out of date before they were published. These two estimates differed regularly by a considerable margin. The figures of the agricultural experts were usually 12–19 per cent. higher than the other figures.‡ It is suggested on the one hand that the experts,

* Huber, Die uebrige landwirtschaftliche Statistik, in *Die Statistik in Deutschland nach ihrem heutigen Stand.* Ed by Zahn, Vol. II, p. 140.

† The difference is small, not over 1 or 2 per cent. For the results of the Bodenbenutzungsaufnahme see *Jahrbuecher fuer Nat. Oek. und Stat.*, Vol. 105. *Volkswirtschaftliche Kronik*, p. 295 ff. The estimates are found in the *Vierteljahrssheft zur Statistik des deutschen Reiches*, Vol. 23, 1914, I, p. 130.

‡ See Ballod, *Gueterbedarf und Konsumtion* in *Die Statistik in Deutschland*, Vol. II, p. 610. See also Morgenroth, *Die Lebensmittelversorgung des deutschen Volkes wahrend des Krieges*, *Deutsches Statistisches Zentralblatt*, Vol. 6, 1914, column 323. The discrepancy between the two sets of figures is even greater than Ballod states it. In Bavaria and Wuerttemberg and some other small states in this period both sets of crop estimates were made by agricultural experts. The difference in the two estimates in Prussia in 1894 varied from 13 per cent. for winter wheat to 33 per cent. for oats. By averaging in Bavaria and Wuerttemberg where the difference in the estimates was very small, the average difference is considerably reduced. The reason for the difference in these states was the slightly different time at which the two estimates were made. Since 1899, the number of crop reporters has been nearly doubled, a circumstance that might lead to greater accuracy. See *Vierteljahrssheft zur Statistik des Deutschen Reiches*, 1894, Vol. III, part III, pp. 38–48; part IV, p. 140; 1899, Vol. VIII, part III, p. 65; *Ergaenzungsheft to part IV*, p. 9, 16.

where farmers, would tend to generalize from their own good crops, and on the other that the returns gathered by the communal authorities would show understatement due to fear of taxation on the basis of the returns.

Which of these estimates is nearer the truth? How far do the estimates of the agricultural experts overstate the real harvest? The only piece of convincing evidence on the amount of overstatement is contained in an article by Ballod, which appeared in Schmoller's *Jahrbuch* for the present year and to which Ashley does not refer.* The amount of wheat and rye ground in mills plus the amount used for seed plus the amount fed to live-stock should equal the total amount available—the harvest plus the excess of imports over exports. The amount fed to cattle must be estimated roughly. Ballod thinks that 2,000,000–2,500,000 tons is an outside estimate of the rye used for fodder. He finds, however, that there is an excess of rye used either for fodder or due to overestimate of crops of 3,240,000 tons, or 30 per cent. of the harvest for 1908–1909, and of 3,840,000 tons, or 34 per cent., for 1909–1910. A similar excess of wheat, 620,000 tons and 1,170,000 tons, respectively, or 15 and 28 per cent. of the harvests, is found. Ballod explains the discrepancy as due to an overestimate of the rye and wheat crops of 10–15 per cent. Even making some allowance for understatement in the statistics of grist-mill production, the overestimate would still be considerable.

Ashley reduced the Eltzbacher estimates of protein from grains by 15 per cent., the larger of the two figures previously given by Ballod. Eltzbacher, however, makes an even more generous allowance than Ballod for wheat and rye used as fodder and in industry before calculating the amount of grain available for human consumption. For rye he deducts 2,708,-085 tons and for wheat 417,384 tons, or 23 and 9 per cent. of the harvest, respectively. Assuming that the percentages of the crop rather than the amount used as fodder are correct,

* In the article to which Ashley refers especially, the harvest of wheat and rye minus exports in four small East Prussian districts was expressed as a per capita consumption of bread. The consumption appeared to Ballod to be far too high. No allowance was made for use of wheat or rye as fodder or for industrial purposes. Further, an overstatement of yield in one district would not be at all conclusive as to a general overestimate. See Ballod, *Deutsche Volksernaehrung im Kriege*. *Preussische Jahrbuecher*, Vol. 157, 1914, pp. 103ff.

the basis of Ballod's calculation of overestimate is completely altered and without making any allowance for understatement in the statistics of grist-mill production the maximum error in the crop estimates would be 9 per cent. for rye and 11 per cent. for wheat, and not 15 per cent. as Ashley assumes.

The two authors, in the revision of the estimates, increase the allowance for rye used as fodder from 25 per cent. to 30 per cent. of the net harvest (after seed is deducted). This change means a reduction of 25,400 tons of protein in the supply available for human consumption. The possible overestimate of protein available from the rye crop is thus reduced to 4 per cent. There is no justification for a reduction in the crop estimates in view of this change, of more than 7.5 per cent. and a reduction of as much as that would hardly seem to be warranted on the basis of the figures given.*

On the other hand, Kuczynski and Zuntz make two important changes in their estimates, both in the direction of reducing their earlier figures. The total production of buckwheat, millet, and maize is revised, so that the protein available from these crops is reduced by 6,800 tons. The estimate of the production of beans, peas, and lentils is reduced almost half, involving a reduction in protein of 33,800 tons, or a total reduction of 40,000 tons.

The other differences in the estimates of protein available are of minor importance and are cited only to illustrate the statement that all the calculations were too optimistic. The two authors cite, as the basis of their estimate of the annual milk production per cow, the official estimates of Bavaria (1907) of 2,340 liters and of Württemberg of 1,940 liters.† Bavaria has nearly three times as many cows as Württemberg; by weighting the figures in proportion to the number of cows in each state an average of some 2,240 liters is secured. But the higher of these two figures, and that to which the greatest weight is attached, is an average of guesses made for the dif-

* The protein from wheat and rye accounts for about three fourths of the protein derived directly from grains and potatoes. The question can be waived as to whether the estimates for the proportion of the crop used as fodder are too high. If they are, they absorb, so to speak, an error in the crop estimates. The net result is to lower the amount of protein calculated as available for human consumption just as effectively as by a reduction in estimated harvest. No change has been made in the supply of meat available as a result of increasing the estimate of the amount of rye used as fodder.

† Kuczynski and Zuntz, *op. cit.*, p. 144.

ferent provinces by agricultural experts in consultation with inspectors of breeding, an altogether unsafe basis for a generalization and one that would probably err on the side of overestimation.*

With reference to the estimates of "dead weight" used to figure the total meat supply, it is admitted by the two authors that the figures used are too high, but the use is justified on the ground that some animal fats used for human consumption are not included in the "dead weights." A note states that the usual estimates of protein content are too high and of fats too low. It seems inferable that in expressing the food value in protein and calories a correction is made to give the true composition of the "dead weights."†

Ashley's criticism based on the overestimate of the "dead weights" loses its force if such a correction is made.

To sum up this discussion of the estimates of protein available: the final results do not differ much from Ashley's conclusion. Of the 162,000 tons discrepancy in the protein from grains and potatoes, an excess of 94,000 tons is admitted by the two authors in their revision and of 30,000 tons more is proved by the actual figures of the 1914 crops. Disregarding the minor items of protein in milk and the overestimate involved in the "dead weights," if a further reduction of 20,000 to 50,000 tons is made for possible crop overestimates the amount of protein available, 1,444,000 to 1,414,000 tons, corresponds fairly closely with Ashley's results. This computation leaves out of account a further reduction of protein available due to

* Die Milchwirtschaft in Bayern, Heft 78 der Beiträge zur Statistik des Koenigreichs Bayern. Hrsg. v. K. Statistischen Landesamt, pp. 18-19.

A reference is given also to a later estimate for Württemberg (1910) of 2,128 liters. This figure is based on the result of milk tests on 344 cows of three breeds on 59 farms in different parts of the kingdom. The number of tests is altogether too small to form a reliable basis for generalization. Milk tests are more likely to be carried out on farms where production is above the average. Tests, for example, of 834 cows in Jefferson County, N. Y., showed an average annual production of 6,621 lbs. as compared with census figures for the county for 1900 of only 4,310 lbs. Milk tests in Bavaria are carried out on cows used for breeding.

See Die Milchversorgung in Württemberg, O. Truedinger, 1914, Schriften des Vereins für Sozialpolitik, Vol. 140, Part IV, pp. 19-20. Truedinger made the earlier estimate for Württemberg of 1,940 liters. See also H. H. Wing, The Formation of Cow-Testing Associations. Circular No. 17, April, 1913, Cornell University Agricultural Experiment Station of the College of Agriculture, Dept. of Animal Husbandry, p. 54. Figures for the tests in Jefferson County were kindly furnished me by Professor G. F. Warren, Cornell University.

† Kuczynski and Zuntz, *op. cit.*, p. 135, note, p. 139. "Infolgedessen wird meistens ein zu hoher Eiweißgehalt und ein viel zu geringer Fettgehalt angegeben. . . . Hier wurde tunlichst die durchschnittliche Zusammensetzung im 'Schlachtwicht' berücksichtigt."

possible loss under war conditions of home-grown fodder materials, for which Eltzbacher made an allowance of some 38,000 tons of protein.

The two authors practically concede in advance the justice of Ashley's criticism of the estimates of daily requirement of protein. After giving 70 to 80 grams as the physiological minimum for efficiency, 10 per cent. is added to allow for unavoidable waste and 5 per cent. more for a certain "excess-nourishment," in all approximately 92 grams. Ashley accepts 92 grams as the lowest reasonable minimum.

The final results of the two authors are much less optimistic than the conclusions of the Eltzbacher publication. They find a deficit of home-production of 21 per cent. of the requirement of protein and 10 per cent. of the requirement of calories; and this requirement itself means 16 per cent. less of protein and 19 per cent. less of calories than was consumed on the average before the war.

There remains the question as to the possible additions to the supply of protein which can be expected from the special measures of the government. Most of the estimates are pure guesses, without any trustworthy statistical basis. Almost half, 217,000 tons, of the total addition (480,000 tons) expected is to be achieved by changes in the keeping of livestock, lessening the waste of fodder and reducing the daily ration of some 3,000,000 "overfed" cows. The most dubious assumption in the calculation is that a saving of 249,000 tons of crude protein can be affected in the fodder ration without lessening at all the average production of milk of 2,200 liters. A calculation is made that the stock of pigs will have to be reduced by one third and of cows by one tenth as a consequence of the cutting off of the import of foreign fodder materials.* It is estimated that the prohibition of the use of bread-grains as fodder will add, if observed, 78,300 tons of protein to the supply available. Ashley thinks, and probably correctly, that the prohibition was largely evaded at first. Furthermore to reckon the entire amount of protein available in the grain estimated as used for fodder reopens the question as to a possible overestimate of this amount and of an overestimate of crop returns. In de-

* Eltzbacher, *op. cit.*, pp. 121-122. The elimination of the poorest tenth of the cows might tend to raise the average production.

fault of more certain evidence on these points, a somewhat liberal margin must be allowed.

In the revision, the two authors, if they were responsible for the estimates, seem to have realized the doubtful value of some of them. The attempt to calculate the amount added by the different measures of the government is abandoned completely. Attention is centered on the question of the supply of fodder materials, but the method of calculation is wholly altered. Instead of estimating the number of pigs and cattle that were dependent on the supplies of foreign fodder, a laborious estimate is made of the probable supply of the fodder materials of the Empire and of the total requirement of each kind of live-stock. They find that the total heat energy of fodder consumed by live-stock in 1912-13 was double the heat energy of foods used for human consumption. The actual consumption of fodder in these two years exceeded the minimum requirement as calculated by the two authors by 14 per cent. of crude protein and 8 per cent. of calories. One half of this difference might be saved by avoiding waste and reducing over-feeding: the remainder, the unavoidable waste, is added to the minimum requirement to make the practical requirement. During the war, with imports of fodder cut off, the supply is 13 per cent. below the practical requirement of crude protein and 12 per cent. below that of calories. If the entire deficit of calories and protein for both men and animals is reduced to a deficit of fodder, eliminating double counting, the available supply of protein is found to be 20 per cent. and that of calories 18 per cent. less than the practical requirement. The conclusion is drawn that the only way out of the difficulty is to reduce still further the number of cattle and pigs.

In summary the criticisms of Ashley seem to have been anticipated by the two authors in their revision, and it seems to me that Ashley's conclusions, though based in part on unsatisfactory or insufficient evidence, are substantially correct.

A few words should be said about the limitations of these statistics. They apply only to Germany proper. No account is taken of the areas of hostile territory occupied by the German armies, Belgium, Northern France, and Russian

Poland, nor of the populations of these districts. No deduction from the total food requirement is made for the possibility that the German armies operating in enemy territory could live off the country, and no addition to the requirement of food is made for prisoners of war held in Germany. The population is assumed constant from July, 1914. No account is taken further of the supplies of grain on hand at the end of the season left over from the 1913 crop. It may be that in these omissions some important factor has been disregarded.

It may be suggested that the amount of protein physiologically necessary is a quantity which has been variously estimated and which therefore offers no certain standard by which to test a deficit of food supply. Estimates are usually based either on statistics of consumption of healthy and efficient laborers or on laboratory experiments. A very low estimate of 50-60 grams daily was made by Professor Chittenden of Yale.* He made some experiments in which he showed that the norm previously accepted as the minimum requirement of protein was much higher than was absolutely necessary. It may be noted in passing that though Ashley and Kuczynski and Zuntz agree on a practical requirement of 92 grams of protein, the two authors include in it an allowance of 10 per cent. for unavoidable waste. A test to which no objection could be made would be to compare the available supply with the consumption of protein before the war of approximately 110 grams.†

In a computation of the available food supply, to deal with averages is not an entirely correct procedure. The food supply is not divided up among the population equally. Even in normal times there are some who do not get enough to maintain efficiency, and there is a large class who can afford no surplus of nourishment. For these classes a shortage of food supply means immediate loss of efficiency or suffering or both, and for these classes an increase of prices is tantamount, for

* Professor Chittenden's experiments are mentioned by Eltzacher in defense of his own low figure of 80 grams.

† 110 grams for an adult male with moderate work. Per capita of the actual population 83.4 grams were consumed before the war, as compared with 86.7 grams reckoned on a basis of about 92 grams per adult male. See Kuczynski and Zuntz, *op. cit.*, pp. 156-158.

all practical purposes, to a shortage of food. In spite of the maximum price regulations adopted by the German government, prices of food-stuffs in Berlin in one year of war have risen 70 per cent. since July, 1914.* The well-to-do classes, do not have to limit seriously their consumption of food except in case of those food-stuffs, notably bread and milk, the consumption of which is regulated by the card system with a fixed maximum amount which any one person may buy.

But the situation has been materially changed in some respects since these estimates were made. Forecasts of the new crops indicate a much better harvest, especially of wheat and rye, than was secured in 1914. The situation in Austria-Hungary will be much improved by the success of the wheat crop of Hungary, the forecasts of which indicate a very considerable increase over that of last year. Austria normally imports some 300,000 tons of wheat: the relative failure of the 1914 harvest in Hungary made the situation much worse than usual. Germany's harvests are much more like an average crop, though probably not equal to the yields of 1912 and 1913. In another year of war, Germany's deficit will therefore be smaller than that calculated for 1914.

Furthermore, Germany has been able to import considerable supplies of animal food products from Holland and Denmark. Figures, which Ashley gives, indicate a somewhat larger import than in normal times of butter, eggs, cheese, and fish.† Germany takes almost the whole of the surplus of the Dutch fisheries.

The success of the operations against Servia has opened up Bulgaria's reserves of wheat and other grains. Her normal exports of wheat amount to nearly 300,000 tons, or 7 per cent. of Germany's home production. Some of her surplus normally goes to Austria. If all were sent to Germany and all used for food, it alone would mean an addition of 20,300 tons to the supply of protein. In addition there is a considerable surplus of corn and barley and a surplus available for immediate needs of a somewhat uncertain amount left in the country from last year's crops. Bulgaria exports an average

* Ashley, *op. cit.*, p. 455.

† Ashley, *op. cit.*, p. 454. See also New York Times, Dec. 17, 1915.

of \$5,000,000 worth of animal products yearly. Negotiations with Rumania for the sale of large quantities of grain have been completed.* Rumania's surplus of wheat is much larger than that of Bulgaria, amounting normally to 1,460,000 tons.† This would mean an addition to the annual supply of nearly 100,000 tons of protein. Besides, there are large quantities of corn and barley which can be used to supply the deficiency in fodder. A rough estimate would place the surplus of these crops available for export at one fourth to one third of the deficit in Germany. With these new sources of fodder materials opened, it is possible that a larger number of pigs and cattle were slaughtered than was necessary.

In conclusion, there is little possibility that Germany can be starved. Her supplies are probably sufficient to cover the minimum practical requirement. Her food supply falls considerably short of the actual rate of consumption in 1912-13, and it must be conserved and carefully distributed to ensure a sufficiency in the last months before the new harvests are available. There are distinctly less meat and animal products available than in normal times. The serious danger, it seems to me, is that disaffection may be spread among the working classes by restrictions on the consumption of food-stuffs, and above all by the increase in prices, which may seem to them entirely unnecessary if, as the government has announced, there is really enough food for all.

* See New York Times, news items in issues of Dec. 23 and Dec. 26, 1915.

† Rumania's crop for 1915 is estimated to be 24 per cent. larger than the average of 1909-13. These figures for the normal exports are taken from the Monthly Crop Report, published by authority of the Secretary of Agriculture, Vol. I, No. 5, p. 48, Sept. 15, 1915. They are based on the average of the last 5 years, 1909-13, as reported by the International Institute of Agriculture at Rome. In calculating the available protein, the same process has been followed as is used by Kuczynski and Zuntz.